3.3.2 Earthquake

An ***earthquake*** is ground shaking and radiated seismic energy caused most commonly by a sudden slip on a fault, volcanic or magmatic activity, or other sudden stress changes in the earth. An earthquake of magnitude 8 or larger on the Richter Scale is termed a great earthquake. Fortunately, Montana has not experienced a great earthquake in recorded history. A great earthquake is not likely in Montana but a major earthquake (M 7.0-7.9) occurred near Hebgen Lake in 1959 and dozens of active faults have generated M 6.5-7.5 during recent geologic time.

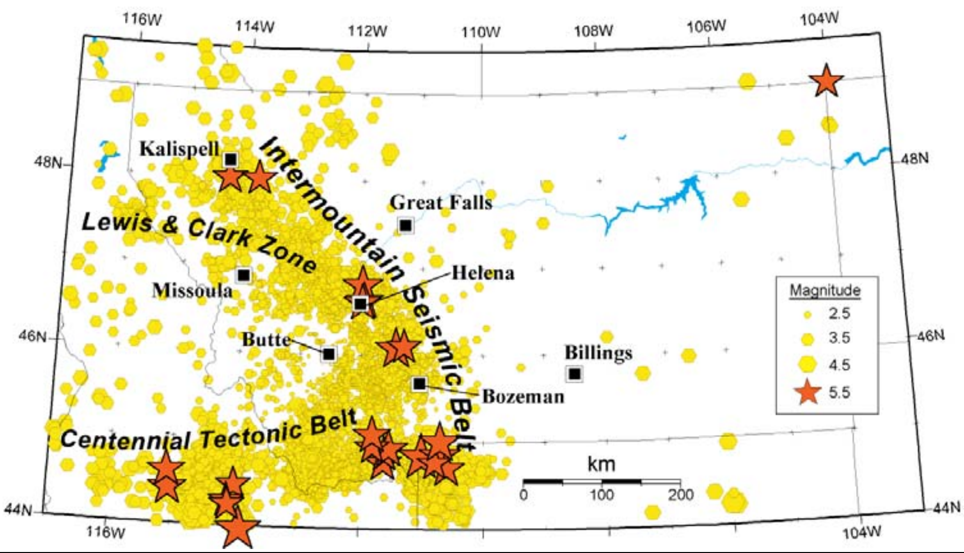
3.3.2.1 Background

- Magnitude and intensity are used to describe seismic activity from earthquakes.
- Magnitude is a measure of the total energy released. Each earthquake has one magnitude, usually measured on the Richter Scale
- Intensity is used to describe the effects of the earthquake at a particular place. Intensity differs throughout the area and is given a value on the Modified Mercalli Scale.
- Seismic events may lead to landslides, uneven ground settling, flooding, and damage to homes, dams, levees, buildings, power and telephone lines, roads, tunnels, and railways. Broken natural gas lines may cause fires.
- Scientists continue to study faults in Montana to determine future earthquake potential. Faults are cracks in the earth's crust along which movement occurs.
- Thousands of faults have been mapped in Montana, but scientists think only about 95 of these have been active in the past 1.6 million years (the Quaternary Period).
- Although it has been over four decades since the last destructive earthquake in Montana, small earthquakes are common in the region, occurring at an average rate of 7-10 earthquakes per day.
- The largest earthquake in Montana, the 1959 Hebgen Lake event, caused more than $11 million in damage.
- The second most-damaging earthquakes were the October 1935 Helena earthquakes, which caused more than $4 million in damage.

Sources: FEMA 2004e; USGS, 2003a; Stickney and others, 2000; NISEE, 1998

A belt of seismicity known as the Intermountain Seismic Belt extends through western Montana, from the Flathead Lake region in the northwest corner of the state to the Yellowstone National Park region (**Figure 3.3.2-1**).

Figure 3.3.2-1 Intermountain Seismic Belt
Source: MBMG, 2004.



3.3.2.2 History of Earthquakes in Montana

Montana is one of the most seismically-active states in the United States. Since 1925, the state has experienced five shocks that reached intensity VIII or greater (Modified Mercalli Scale)**.** During the same interval, hundreds of less severe tremors were felt within the state. Montana's earthquake activity is concentrated mostly in the mountainous western third of the state, which lies within the Intermountain Seismic Belt that also includes southeastern Montana, western Wyoming, and central Utah (**Figure 3.3.2-1**).

The first confirmed earthquake in Montana was reported in Helena in 1869. The strength of this quake caused houses to shake, overturning furniture and breaking dishes.

Table 3.3.2-1 shows the historic earthquakes of Montana and surrounding regions with magnitude of 5.5 or greater since 1900. Although one significant earthquake occurred in eastern Montana in 1909, the majority have occurred along the Intermountain Seismic Belt and Centennial Tectonic Belt in western Montana. **Table 3.3.2-2** shows deaths and major damages from two major Montana earthquake events.

Table 3.3.2-1 Historic Earthquakes of Montana and Surrounding Regions with Magnitudes of 5.5 or Greater Since 1900

Date	Magnitude	Approximate Location
05/16/09	5.5	Northeast Montana
06/28/25	6.6	Clarkston Valley
02/16/29	5.6	Clarkston Valley
10/12/35	5.9	Helena
10/19/35	6.3	Helena
10/31/35	6.0	Helena
07/12/44	6.1	Central Idaho
02/14/45	6.0	Central Idaho
09/23/45	5.5	Flathead Valley
11/23/47	6.1	Virginia City
04/01/52	5.7	Swan Range
08/18/59	7.5	Hebgen Lake
08/18/59	6.5	Hebgen Lake
08/18/59	6.0	Hebgen Lake
08/18/59	5.6	Hebgen Lake
08/18/59	6.3	Hebgen Lake
08/19/59	6.0	Hebgen Lake
10/21/64	5.6	Hebgen Lake
06/30/75	5.9	Yellowstone Park
12/08/76	5.5	Yellowstone Park
10/28/83	7.3	Challis, ID
10/29/83	5.5	Challis, ID
10/29/83	5.5	Challis, ID
08/22/84	5.6	Challis, ID
07/26/05	5.6	Beaverhead County, MT

Source: Stickney and others, 2000

Table 3.3.2-2 Deaths and Damages from the Two Most Damaging Montana Earthquakes

Date	Locality	Deaths	Damages	Damages in 2007 $
October 19, 1935	Helena, Montana	2	$4 million	$60.7 Million
October 31, 1935	Helena, Montana	2		
August 18, 1959	Hebgen Lake, Montana	28	$11 million	$78.6 Million

Source: USGS, 2004a

3.3.2.2.1 Largest Earthquake in Montana: Hebgen Lake, August 18, 1959 Magnitude 7.5, Intensity X

The Hebgen Lake Earthquake of 1959 was the largest earthquake in Montana and the 14th largest earthquake in the contiguous United States in historic times (Stover and Coffman, 1993). This earthquake caused 28 fatalities and about $11 million in damage to highways and timber. It was characterized by extensive fault scarps, subsidence and uplift, a massive landslide, and a seiche (large wave) in Hebgen Lake. A maximum intensity X or greater (Modified Mercalli Scale) was assigned to the epicentral area.

Photo 3.3.2-1
Aerial View of Madison Canyon Slide with Earthquake Lake in the background. The Hebgen fault crosses the dark forested spur near the head of lake. Madison County, Montana. August 1959.
Source: USGS, 2004a

The most spectacular and disastrous effect of the earthquake was the huge landslide of rock, soil and trees that cascaded from the steep south wall of the Madison River Canyon. This slide formed a barrier that blocked the gorge and stopped the flow of the Madison River and, within a few weeks, created a lake almost 53 meters (174 feet) deep. The volume of material that blocked the Madison River below Hebgen Dam was estimated at 28 to 33 million cubic meters (988.8 to 1165.4 cubic feet). Most of the 28 deaths were caused by rockslides that covered the Rock Creek public campground on the Madison River, about 9.5 kilometers (5.9 miles) below Hebgen Dam.

Photo 3.3.2-2
Hebgen Earthquake, Red Canyon Fault Scarp (1959) where it cut through the Blarneystone Ranch. The house sits on the down-thrown block. The fault scarp here is 10 to 12 feet high. The roof of a small collapsed shed is visible on the up-thrown block. Gallatin County, Montana.
Source: USGS, 2004a

New fault scarps as high as 6 meters (19.7 feet) formed near Hebgen Lake during this earthquake. The major fault scarps formed along pre-existing normal faults northeast of Hebgen Lake. The earth-fill dam sustained significant cracks in its concrete core and spillway, but it continued to be an effective structure.

Many summer houses in the Hebgen Lake area were damaged; houses and cabins shifted off their foundations, chimneys fell, and pipelines broke. Most small-unit masonry structures and wooden buildings along the major fault scarps survived with little damage when subjected only to vibratory forces. Roadways were cracked and shifted extensively, and much timber was destroyed. Highway damage near Hebgen Lake was due to landslides slumping vertically and flowing laterally beneath pavements and bridges, which caused severe cracks and destruction. Three of the five reinforced bridges in the epicentral area also sustained significant damage.

High intensity earth movements were observed in the northwest section of Yellowstone National Park. Here, new geysers erupted, and massive slumping caused large cracks in the ground from which steam emitted. Many hot springs became muddy.

3.3.2.2.2 Helena Earthquakes – Up to Magnitude 6.3

Starting with a small tremor on October 3, the City of Helena, Montana suffered through a devastating series of several hundred earthquake shocks in the month of October, 1935, including three damaging earthquakes on October 12th, 18th, and the 31st. Although no surface ruptures occurred during this earthquake sequence, shaking from the earthquakes damaged more than half of Helena's buildings. The epicenters of the 1935 series of earthquakes is not precisely known, but were probably located about 6 km (3.7 miles) north of the city, possibly along the Prickly Pear fault zone (Qamar and Stickney, 1983). The following description of the earthquake is from the National Information Service for Earthquake Engineering (NISEE, 1998).

Previous to the cluster Helena earthquake tremors there had been little recorded seismic activity in the area of Helena. The earthquakes disproved a then-popular misconception that all seismic activity within the United States occurred solely in California and Alaska. Before October 1935, the spurious sense of immunity from natural disaster contributed to an atmosphere of uncontrolled construction in Helena. Earthquake hazard and earthquake-resistant design methods were disregarded. Older, antiquated construction in Helena behaved predictably during the tremors.

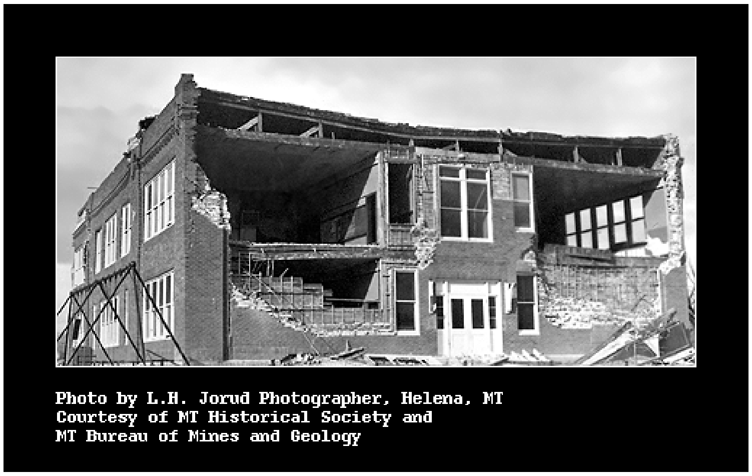


Photo 3.3.2-3
Bryant Elementary School in Helena, Montana suffered increasing damage in the series of 1935 earthquakes which began October 12th. Until reconstruction was completed, its 276 students attended school in the basement of Central school.
Source: Utah NEHRP, 2004

Damage in Helena included collapsed chimneys, fallen parapets, gables, and end walls, shattered walls parallel to interior framing, with partial or total collapse of structures as the ultimate end. Most buildings with un-reinforced masonry-bearing walls were severely damaged within the month-long barrage of seismic activity. Likewise, industrial smoke stacks built almost entirely of brick fell down.

The inadequacies of existing structural design requirements became painfully obvious after a large earthquake. The October 18th earthquake brought serious damage to City Hall, as well as the area to the east of the mercantile district along Main Street. There, many chimneys fell down, brick dwellings were seriously damaged or partly collapsed, brick veneer was thrown off, and many commercial, school, and public buildings were greatly affected, some destroyed. The worst wreckage occurred in structures on the softer alluvial soil toward the valley, notably the new High School and the Bryant School.

The last large shock of October 31st caused the collapse of parts of buildings which previously had been seriously affected, but which remained standing, including the new High School and the Kessler Brewery. It also caused new damage in many structures not previously seriously affected. The failure of the high school is directly attributable to deficiencies in design. The skeleton frame was designed for vertical (not horizontal) loads and reinforced for such loads only. Walls could offer no stability to the frame. As a result, the walls broke up and shattered, and the frame was cracked or ruptured in many places.

3.3.2.2.3 Dillon Earthquake

On the evening of July 25, 2005 at 10:08 p.m. a magnitude 5.6 earthquake occurred in southwestern Montana 16 kilometers north of Dillon. The Intensity VI shaking at Dillon caused damage to some masonry structures, particularly older chimneys. A large chimney on Old Main Hall on The University of Montana-Western campus in Dillon sustained severe damage and was subsequently removed to prevent total collapse. Beaverhead County DES personnel estimated that that up to 60 percent of the older masonry chimneys in Dillon were damaged. An overpass above Interstate-15 located 6.5 km southwest of the epicenter experienced sheared anchor bolts and spalled concrete but remained in good service. Ground cracks formed in weakly consolidated deposits approximately 3 km southwest of the epicenter, apparently a result of strong ground shaking in weak soils but were unrelated to primary faulting. The Dillon earthquake occurred on a previously unknown fault that apparently lacks surface expression (Stickney, 2007).

3.3.2.3 Declared Disasters from Earthquakes

No declared disasters from the affects of earthquake damage have been made since 1974.

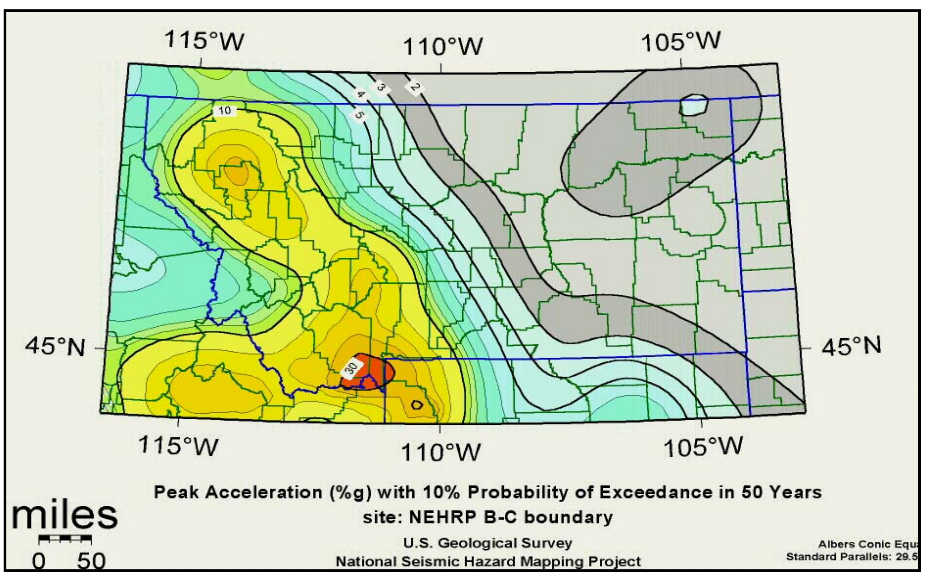
3.3.2.4 Vulnerability to Earthquakes

Earthquakes will undoubtedly continue to occur in Montana, however the precise time, location, and magnitude of future events cannot be predicted. As discussed above, earthquake hazard areas in Montana are concentrated in the western portion of the state, which is part of the Intermountain Seismic Belt (**Figure 3.3.2-1**). Numerous factors contribute to determining areas of vulnerability: historical earthquake occurrence, proximity to faults, soil characteristics, building construction, and population density, to mention a few.

3.3.2.4.1 Earthquake Hazard Areas

The U.S. Geological Survey (USGS) has generated earthquake hazard areas (indicated by peak acceleration values) for the continental United States. The peak acceleration values applicable to Montana are shown in **Figure 3.3.2-2.** The contour values show the earthquake ground motions with a common probability of being exceeded in 50 years. The ground motions considered at a given location are those from all future possible earthquake magnitudes at all possible distances from that location. On a given map, for a given probability of exceedance, PE, locations shaken more frequently, will have larger ground motions.

Figure 3.3.2-2 Peak Acceleration Values in Montana
Source: USGS, 2004a



As **Figure 3.3.2-2** shows, the southwest portion of the state is the most susceptible to future earthquakes. Considering both population concentration and historic seismicity, Helena and Bozeman are the most vulnerable locations, followed by Missoula, Butte and Kalispell. These areas also are experiencing some of the greatest population growth rates in the state. Without mitigation of earthquake effects, the potential for losses will increase as population growth and building and infrastructure development expands.

Seasonal tourism increases exposure to seismic hazards in all areas, but the greatest exposure is in the Yellowstone National Park-Hebgen Lake region, where several million people visit annually. The fact that the majority of the 28 fatalities associated with the 1959 Hebgen Lake earthquake were out-of-state visitors confirms this point. In contrast, Billings and Great Falls, respectively the first and third largest cities in the state, have relatively low earthquake hazard ratings.

3.3.2.4.2 Earthquake Loss Estimation Models

Earthquake losses were estimated by using the HAZUS (beta v 28.b) Earthquake model developed by the Federal Emergency Management Agency (FEMA). Counties with a high earthquake recurrence rates were compared by evaluating the annualized loss estimate in the HAZUS model. The annualized loss estimate addresses two key components of seismic risk: the probability of ground motion within a given study area and the consequences of the ground motion (FEMA, 2001). The result of a FEMA (2001) HAZUS analysis indicated that estimated annualized losses for the State of Montana are $15.6M, based on 1999 values.

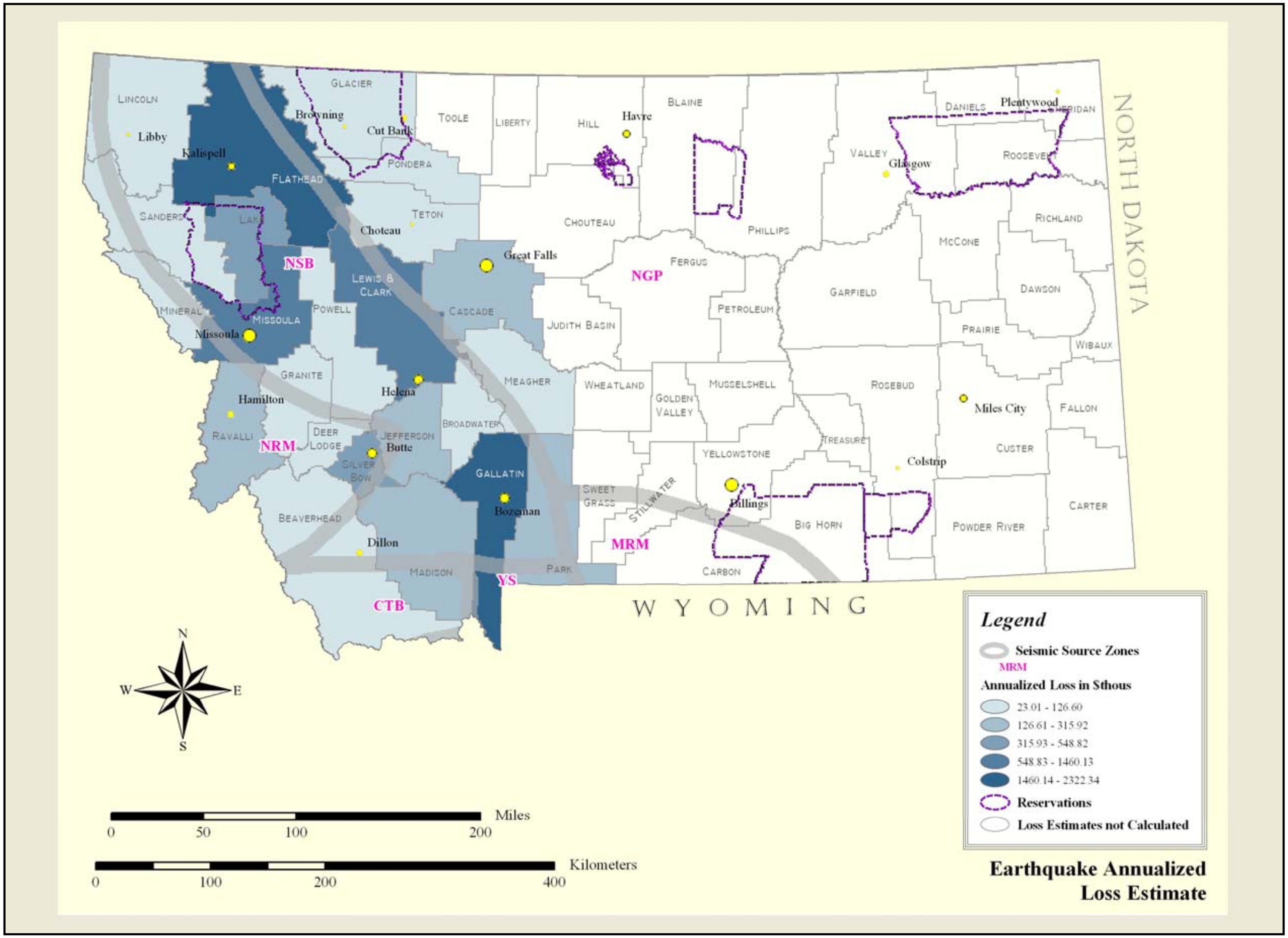
The HAZUS annualized loss estimate conducted for this Hazard Assessment uses default general building stock data in the model and estimates average losses per year by county. Counties with little history of earthquake activity were not included in the analysis. Ground motion was based on U.S. Geologic Survey probabilistic motion default parameters in the model (see **Figure 3.3.2-2**). The analysis used the ground motion demand computed at the centroid of each census tract. The results show county-wide estimated losses on an annual basis for general building stock. The analysis was not completed on other critical facilities or infrastructure due to a lack of digital data for these locations.

Table 3.3.2-3 and **Figure 3.3.2-3** show the results of the HAZUS analysis for the 10 counties with the highest potential for earthquake damage. The analysis shows that Gallatin County would have the highest losses, followed by Flathead, Missoula, and Lewis and Clark Counties. This result is somewhat surprising, as Missoula County is considered to have a relatively low seismic activity (Qamar and Stickney, 1983), and no earthquakes above 5.0 on the Richter Scale have ever been documented in Missoula County. Its proximity to the Intermountain Seismic Belt and concentrated population base may increase its vulnerability over the more frequent, less populated areas.

Table 3.3.2-3 Ten Counties with Highest Losses Using the HAZUS Earthquake Annualized Loss Function

County	Cost Structural Damage	Cost Non-Structural Damage	Cost Contents Damage	Inventory Loss	Wage / Income Related Loss	Loss Ratio	Total Annualized Loss
Gallatin	$276,920	$1,407,160	$453,090	$6,370	$178,800	.0237	$2,322,340
Flathead	$217,200	$1,098,980	$419,230	$6,340	$116,690	.0200	$1,858,440
Missoula	$202,250	$866,350	$262,630	$3,130	$125,770	.0118	$1,460,130
Lewis and Clark	$163,300	$730,480	$231,330	$2,420	$84,390	.0171	$1,211,910
Silver Bow	$76,720	$322,120	$96,330	$1,040	$52,610	.0134	$548,820
Lake	$57,730	$294,050	$115,950	$1,380	$28,090	.0167	$497,200
Ravalli	$47,690	$183,210	$57,420	$1,030	$26,580	.0083	$315,920
Cascade	$46,160	$164,590	$48,070	$510	$38,610	.0029	$297,930
Jefferson	$31,560	$144,540	$46,030	$210	$9,960	.0085	$232,300
Madison	$27,480	$141,540	$42,870	$650	$12,930	.0231	$225,460

Figure 3.3.2-3 Earthquake Annualized Loss Estimate



3.3.2.4.3 Earthquake Recurrence Intervals

Qamar and Stickney (1983) developed earthquake recurrence intervals for high-incidence seismic zones in the state based on historic earthquake information. Wong and others (2005) compiled a more complete historic earthquake catalog and used it to develop improved recurrence relations for five regional seismic source zones in Montana. The five regional source zones are: Northern Intermountain Seismic Belt, Centennial Tectonic Belt, Northern Rocky Mountains, Middle Rocky Mountains, and Northern Great Plains (**Figure 3.3.2-3**). These results suggest that a magnitude 6 or larger earthquake may strike the Northern Intermountain Seismic Belt once in a 23-year period. This seismic source zone includes the cities of Kalispell, Missoula, Helena, Bozeman, and Livingston, as well as the rapidly growing rural population and infrastructure surrounding those cities.

Table 3.3.2-4 Earthquake Recurrence Rates by Seismic Source Zone

Seismic Source Zone	M*5	M*6	M*7	# Quakes M >=6
Northern Intermountain Seismic Belt	3.84	22.6	133.	1
Centennial Tectonic Belt	8.69	75.7	659.	1
Northern Rocky Mountains	36.6	420.	4821.	0
Middle Rocky Mountains	237.	1,754.	13,000.	0
Northern Great Plains	26.8	184.	1281.	2

* Predicted return time (in years) of earthquakes with magnitude M or greater.
Note: These values reflect recurrence times in the entire source zone.
Source: Wong and others, 2005

3.3.2.5 Review of Potential Losses in Local PDM Plans

Figure 3.3.2-4 presents the Earthquake Hazard Risk Map. The colors represent a high-medium-low risk rating based on information in the Local PDM Plans. The gray color indicates this hazard was not assessed in the Local Plan. The hatch pattern indicates the Local Plans were not available for review. For electronic users of the State Plan, clicking on a county or tribal reservation will take you to the Local Plan where further information is available.

Table 3.3.2-5 presents a summary of potential loss estimates due to earthquakes as calculated in the Local PDM Plans. Earthquake loss is described in terms of its effect on buildings, society and the economy, where generally:

- Building loss is presented either as a dollar value or a high-moderate-low rating and typically refers to the potential loss to critical facilities in the jurisdiction.
- Societal loss is presented either as the number of lives at risk or as a high-moderate-low rating representing the potential for loss of human life.
- Economic risk is presented as a dollar value or high-moderate-low rating referring to the potential impact to the economy of the local jurisdiction.

References cited in **Table 3.3.2-5** correspond to a description of the method used to calculate potential loss that can be found in *Section 7.14.*

Figure 3.3.2-4 Hazard Risk Map: Earthquake

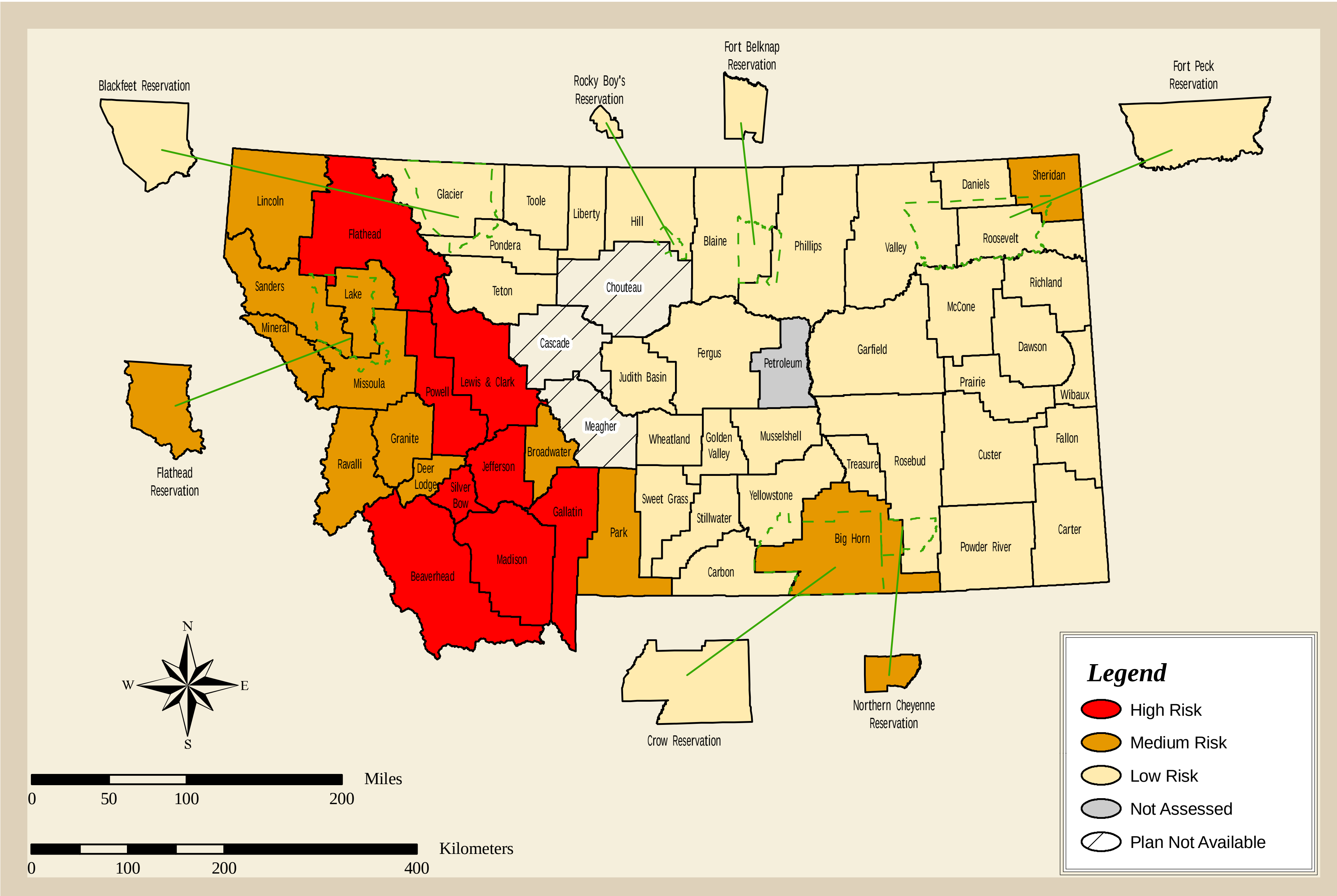


Table 3.3.2-5 Potential Losses from Local Plans: Earthquake

DES District	Jurisdiction	Building Loss	Societal Loss	Economic Loss	Reference
1	Deer Lodge County	$3,900,000	Moderate	High	1
1	Flathead County	$300,000,000	10-70 K	Very High	8
1	Flathead Reservation	$40,550,000	1586	NA	2
1	Granite County	$5,300,000	Low	$490,000	1
1	Lake County	$40,550,000	1,586	NA	2
1	Lincoln County	2	1	NA	9
1	Mineral County	$20-$50,000	Low	NA	10
1	Missoula County	$10-$15 million	Low	NA	10
1	Powell County	Low	Low	NA	10
1	Ravalli County	$1-$2 million	Moderate	NA	10
1	Sanders County	NA	NA	NA	
1	Silver Bow County	$300 million	100-300	High	1
2	Blackfeet Reservation	NA	NA	NA	
2	Blaine County	NA	NA	NA	
2	Cascade County	U	U	U	
2	Chouteau County	U	U	U	
2	Fort Belknap Reservation	NA	NA	NA	
2	Glacier County	NA	NA	NA	
2	Hill County	NA	NA	NA	
2	Liberty County	Low	Low	Low	11
2	Pondera County	NA	NA	NA	
2	Rocky Boy's Reservation	NA	NA	NA	
2	Teton County	NA	NA	NA	
2	Toole County	High	High	NA	11
3	Beaverhead County	$20.2 Billion	520,000	NA	5
3	Broadwater County	$50,000,000	50-100	High	1
3	Gallatin County	High	Moderate	High	12
3	Jefferson County	NA	NA	NA	
3	Lewis & Clark County	$400,000,000	262	NA	6
3	Madison County	$4,747,416	NA	NA	7
3	Meagher County	U	U	U	
3	Park County	$82,600,000	Moderate	High	1
3	Sweet Grass County	NA	NA	NA	
4	Carter County	Low	Low	Low	12
4	Custer County	NA	NA	NA	
4	Dawson County	NA	NA	NA	
4	Fallon County	NA	NA	NA	
4	Garfield County	$130,000	Low	Low	1
4	McCone County	$225,000	NA	NA	3
4	Powder River County	$120,000	Low	Low	1
4	Prairie County	NA	NA	NA	
4	Richland County	$225,000	NA	NA	3
4	Wibaux County	NA	NA	NA	
5	Big Horn County	$225,000	NA	NA	3
5	Carbon County	NA	NA	NA	

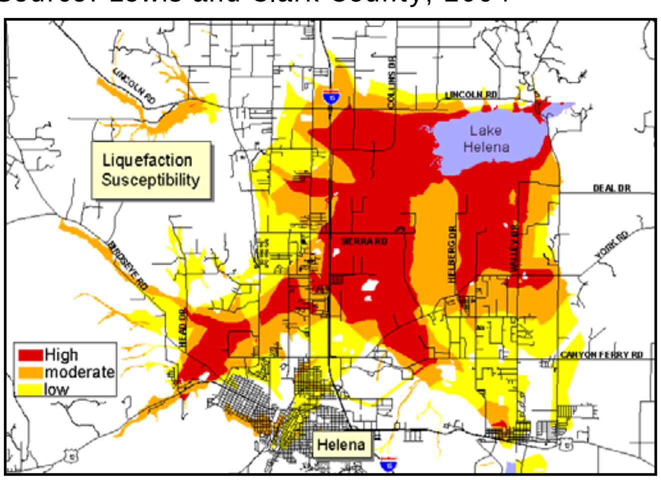
Table 3.3.2-5 Potential Losses from Local Plans: Earthquake

DES District	Jurisdiction	Building Loss	Societal Loss	Economic Loss	Reference
5	Crow Reservation	<$225,000	Moderate	Moderate	3
5	Golden Valley County	NA	NA	NA	
5	Musselshell County	NA	NA	NA	
5	Northern Cheyenne Reservation	<$225,000	NA	NA	3
5	Rosebud County	Moderate	Low	Low	1
5	Stillwater County	NA	NA	NA	
5	Treasure County	Moderate	Low	Low	1
5	Wheatland County	NA	NA	NA	
5	Yellowstone County	NA	NA	NA	
6	Daniels County	NA	NA	NA	
6	Fergus County	NA	8	8	4
6	Fort Peck Reservation	NA	NA	NA	
6	Judith Basin County	NA	NA	NA	
6	Petroleum County	NA	NA	NA	
6	Phillips County	NA	NA	NA	
6	Roosevelt County	NA	NA	NA	
6	Sheridan County	NA	NA	NA	
6	Valley County	NA	NA	NA	

Notes: U = Local PDM Plan not available for review; NA = not assessed in Local PDM Plan
Potential loss was computed was not computed in a uniform manner in Local PDM Plans. See number reference in *Section 7.14* for a description of the methods used to calculate potential building, society and economic loss.

Helena is the only major city in Montana that is known to lie near an active fault capable of causing large earthquakes (Qamar and Stickney, 1983). Lewis and Clark County (2004) completed a HAZUS computer simulation of a 6.3 earthquake in Helena. The simulation revealed that property damage would be nearly $1 billion for an earthquake of this magnitude. Fatalities and injuries would depend upon the time of day that the earthquake would occur, but may cause up to 12 deaths. The model results estimated government building damage would be minimal, but the default government building data built into the model is poor and likely underestimates the potential damage. The Capitol Complex is located in areas that have a very low potential of liquefaction susceptibility. A liquefaction susceptibility map for the Helena Valley is shown in **Figure 3.3.2-5.**

Figure 3.3.2-5 Liquefaction Susceptibility Map for the Helena Valley
Source: Lewis and Clark County, 2004



3.3.2.5.1 Vulnerability of State Property

An analysis of direct exposure of government buildings and infrastructure has not been completed. The default data of government buildings in the HAZUS earthquake prediction model is inadequate to assess structural, non-structural, and content losses. To effectively determine earthquake vulnerability for State property, data identifying locations of State buildings is necessary to determine the exposure and vulnerability. The current PCIIS building database is not geo-referenced and cannot be effectively related to spatial coordinates except in general locations (by city or zip code centroid).

Counties that are highly vulnerable to earthquake loss are those where the annualized earthquake loss ratio is greater than 0.01. **Table 3.3.2-6** shows the counties that meet that criteria and the total value of state buildings and contents that are exposed to earthquake loss.

Table 3.3.2-6 State-Owned Buildings in Counties Highly Vulnerable to Earthquake Loss

County	Annualized Loss Ratio	Building Value	Contents Value	Total Value	State Employee Count
Gallatin	.0237	$628,106,416	$313,624,692	$941,731,108	407
Madison	.0231	$12,293,758	$562,960	$12,856,718	63
Broadwater	.0214	$13,193,938	$9,366,472	$22,560,410	130
Flathead	.0200	$38,697,078	$10,881,240	$49,578,318	600
Jefferson	.0185	$23,951,910	$5,890,780	$29,842,690	759
Lewis and Clark	.0171	$326,386,470	$185,642,670	$512,029,140	4,946
Lake	.0167	$10,924,908	$3,994,159	$14,919,067	120
Silver Bow	.0134	$78,449,461	$23,186,164	$101,635,625	640
Powell	.0130	$103,862,149	$21,170,003	$125,032,152	385
Beaverhead	.0124	$49,682,696	$14,379,360	$64,062,056	122
Sanders	.0118	$1,778,555	$771,777	$2,550,332	57
Missoula	.0118	$683,963,987	$193,808,935	$877,772,922	673
Park	.0106	$3,102,043	$935,509	$4,037,552	79
Meagher	.0100	$673,734	$52,431	$726,165	17
TOTALS		**$1,975,067,103**	**$784,267,152**	**$2,759,334,255**	**8,998**

Source: DOA, Risk Management and Tort Defense Division, 2007

3.3.2.6 Impact of Future Development

New construction in the Intermountain Seismic Belt is taking place in areas vulnerable to earthquake damage. The State Of Montana has adopted the International Building Code (IBC), 2006 edition and seismic provisions or requirements found in the IBC are what the state requires for commercial buildings built in Montana.

Seismic requirements are found throughout the code and are not condensed into a table or chart of requirements. Different building types, different occupancies and different uses all have varying degrees of seismic requirements and even different materials utilized in those different buildings and occupancies carry additional or different requirements i.e. wood construction of a police station would have different seismic requirements than a masonry built police station. A building with an occupant load of over 300 people would require additional seismic considerations than if the building held less than 300 (same use, same materials). The staff of architects and engineers at the Montana Department of Labor and

Industry, Bureau of Building and Measurement Standards perform plan reviews to ensure designers have included the seismic provisions and requirements found in the building code.

The IBC recognizes the differences in seismic activity by evaluating three main parameters; 1) amount of motion – this is a site specific value derived from software using a location's zip code, 2) site class or soil type for a specific building site, and 3) the seismic use group which is the type of building use. These three parameters are analyzed to arrive at a "seismic design category" which the code then provides for specific requirements based on a project's seismic design category label. For example a project located in an area where the ground motion has been determined to be high, the soil type at the site is determined to be such that not much dampening of that motion is likely to occur (not hard rock – silt or loose soil present) and the building is considered an "essential facility" such as a police station or hospital then the seismic design category will calculate out to be such that higher seismic requirements will be placed on that structure. You could have the same motion and the same soil type but have a building that is not essential (could be right across the street from the police station) and the seismic design category would be such that the requirements for seismic design will be lower.

The IBC does not cover single family residences. The State Of Montana has adopted the International Residential Code (IRC), 2006 edition for one and two family residences and townhouses. The State of Montana, Bureau of Building and Measurement Standards does not have jurisdiction over single family residences (they are exempt from the requirements of a building permit by law). Local jurisdictions (cities, counties and towns) can elect to become certified to take on enforcement of single family residences. Currently there are 42 certified jurisdictions including four counties (**Table 3.3.2-7**) that are certified to enforce building codes; however, they must adopt the same codes and operate under the same process as the State of Montana.

Table 3.3.2-7 Jurisdictions Certified to Enforce Building Codes within Intermountain Seismic Belt

County	Jurisdiction Enforcing Building Codes	Area of Enforcement
Broadwater	Townsend*	Within city limits
Deer Lodge	Anaconda/Deer Lodge County	Entire county
Flathead	Columbia Falls, Kalispell, Whitefish	Within city limits
Gallatin	Belgrade, Bozeman, Manhattan, West Yellowstone	Within city limits
Glacier	Cutbank	Within city limits
Lake	Polson*, Ronan	Within city limits
Lewis and Clark	East Helena, Helena	Within city limits
Lincoln	Libby, Troy	Within city limits
Missoula	Missoula	Within city limits
Missoula	Missoula County	County
Park	Livingston	Within city limits
Pondera	Conrad	Within city limits
Powell	Deer Lodge	Within city limits
Ravalli	Darby, Hamilton, Pinesdale*, Stevensville*	Within city limits
Silver Bow	Butte/Silver Bow County	Entire county

Notes: * indicates enforcing residential building codes only
Source: Montana DLI, 2007

Provided future development complies with State building codes, earthquake damage should be minimized. However, damage to new buildings and infrastructure will occur if earthquakes stronger than the "seismic design categories" in the building codes take place.

3.3.2.7 Earthquake Data Limitations

The default data of government buildings in the HAZUS earthquake prediction model is very inadequate. To effectively determine earthquake vulnerability of State property, data identifying locations of State buildings is necessary. The current Montana Department of Administration, Risk Management and Tort Defense Division PCIIS building database is not geo-referenced and cannot be effectively related to spatial coordinates except in general locations (by city or zip code centroid).

Fault mapping and specific local-level hazard mapping (such as liquefaction) is incomplete across the State. Many faults within the State are believed to be unmapped or not studied. Improvements to HAZUS data and continuing research in the areas of geology and earthquakes could significantly improve the vulnerability assessment.

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